

**Columbus
PM10 Monitoring Special Study**

**August 22, 2000
To
August 31, 2001**

**Prepared by
Ambient Monitoring Section
Office of Air Management
IDEM**

May 2002

PM-10 Special Purpose Monitoring Site Columbus, IN

Introduction

Over the years, the Indiana Department of Environmental Management (IDEM) has received numerous complaints from citizens and businesses in the vicinity of the Golden Casting Corp. Foundry in Columbus, Indiana, regarding particulate matter pollution. IDEM operated a Total Suspended Particulate (TSP) monitor downwind of the foundry from 1985 to 1987 resulting in no exceedances of the original health standard for TSP, known as the "National Ambient Air Quality Standard." In 1990 and 1991, a special purpose monitor was sited approximately 2 blocks north/northeast of the foundry and sampled for TSP again. The filters from this study were also analyzed for 14 trace metals. The maximum 24-hour TSP reading during this study was 133ug/m³ as compared to the then existing standard of 150ug/m³. Although there are no standards for the trace metals that were measured, the values recorded during this study were low and not of concern to the public health. In August 2000, in an effort to determine if the concentrations of respirable particulate matter in the area downwind of the foundry posed a health concern to the residents and business neighbors, IDEM established a state-of-the-art continuous particulate monitor to measure only the respirable portion of the particulate (particulate matter less than 10 microns in size) (PM₁₀) in the area. Continuous meteorological parameters were also collected during this study.

This report summarizes the results of the recent monitoring study. It should be noted that during the timeframe of this study, IDEM's Office of Air Compliance worked with Golden Castings as the company implemented dust control measures designed to reduce emissions from various locations within the facility.

Project Plan

In order to determine if a health problem or threat from respirable particulate matter existed in the area around Golden Casting, a PM₁₀ (particulate matter less than 10 microns in size) monitor was located near the facility. The data retrieved from the monitor were compared to the NAAQS for PM₁₀. A meteorological station to measure wind speed (WS) and wind direction (WD) was also located at the site. The monitoring period established at the beginning of the study was one year. This time period would allow for the collection of air quality data through all seasonal variations.

National Ambient Air Quality Standards

The USEPA has established NAAQS for six criteria pollutants. For each pollutant a primary and a secondary standard is set. The primary NAAQS are set to protect the public health of the population, including the health of sensitive populations such as asthmatics, children, and the

elderly. The secondary NAAQS are established to protect the public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. The level of the primary and secondary NAAQS for PM10 are set to the same value. Both a short term (24 hour average) and a long term (annual average) time period is set for both NAAQS. The level of the short term NAAQS is 150 micrograms per cubic meter of air (ug/m³) and the level of the long term NAAQS is 50 ug/m³.

The short term standard is met when the yearly average number of exceedances for a three-year period is less than or equal to one. The long term standard is met when the average of the three-year averages is less than or equal to 50 ug/m³. For the purposes of this study, the number of exceedances allowed would be 1 and the average over the sampling period should be less than or equal to 50.

Particulate Sources

Attachment 1 is a list of the sources reporting emissions of PM10 for 2000 in Bartholomew County. The largest emitter of PM10 is Golden Casting Corp. with estimated emission of 85 tons/year.

Site Location

A mobile sampling trailer was installed in a parking lot north of the General Office Building of Arvin North American Automotive to house the air quality monitor and equipment. The sample inlet was approximately 600 feet north of the property line of the Golden Casting Corp. Foundry. The Golden Casting building was located between 155° to 200° from the monitoring trailer. The property of the facility spanned was located between 145° to 220°. Attachment 2 shows the location of the monitoring site in the city of Columbus. Attachment 3 shows the location of the monitoring site with respect to Golden Casting and the surrounding buildings. The UTM's of the site are 595.330E and 4340.750N. The site is identified using the AIRS (Aerometric Information Retrieval System) site number 18-005-0006.

The PM10 monitor met all siting criteria for PM10 monitoring as set forth in 40 CFR Part 58 and the Indiana Ambient Air Monitoring Quality Assurance Manual.

Sampling Period

The PM10 monitor began collecting data on August 22, 2000 and continued until August 31, 2001. The meteorological monitor collected WS and WD data from September 21, 2000 until August 31, 2001.

Equipment

A Rupprecht and Patashnick (R&P) TEOM 1400a was used to collect PM10 values continuously. The 1400a incorporates a tapered element oscillating micro-balance to measure

particulate loading. Ambient air is drawn from atop the shelter into the unit through a size selective inlet which allows only particulate matter less than 10 microns in size to pass through. A down-tube delivers the air with the particulate in it to the monitor inside the shelter. A filter is placed atop a tapered glass rod, which oscillates between 150 and 400 megahertz. As more particulate is deposited on the filter, the oscillation frequency of the rod changes proportionately to the amount of particulate load. The electronics of the monitor measures the difference in oscillation and calculates the PM10 concentration.

The WS and WD data were collected using a RM Young Model 05305/AQ meteorological system.

Data from the PM10 monitor and meteorological sensors were stored in hourly average readings using an Environmental Systems Corp. (ESC) Model 8816 data logger.

All electronic monitoring and data gathering instrumentation was housed inside an 8x12 foot mobile monitoring trailer environmentally controlled at 72 degrees F (plus/minus 3 degree F).

Data Collection

Every hour the central data system of the Air Monitoring Branch, located in Indianapolis, polled the Columbus site and retrieved the data recorded for the previous hour. The hourly values were reviewed each day to determine monitor operation and the concentrations being collected. The data were compiled in a monthly summary and reviewed by Branch staff for validity, completeness, and compliance with the NAAQS for PM10 concentrations.

Data Quality

All monitors and recording devices were operated according to the standards and procedures set forth in Indiana State Quality Assurance Manual, the applicable sections of 40 CFR Parts 50, 53, and 58, and the individual instrumentation manuals. Periodic calibrations and audits were performed on the instrumentation. All calibration and audit results for the sampling period were within the acceptable limits. Attachment 4 lists the individual results for the TEOM and Attachment 5 lists the results for the meteorological units.

Data Return

For the PM10 sampling period from August 22, 2000 until August 31, 2001 a total of 8990 hours of data were possible. 8486 hours of valid data were collected for a valid data return of 94.4%.

Most invalid data readings consisted of one to three hours every few weeks as staff performed site checks, filter changes, or quality assurance activities. One large block of invalid data, 357 hours, occurred in June. A new filter was improperly seated in the instrument. Once this problem was discovered, an attempt to correct it failed and more data were lost until the filter was properly seated and the instrument began collecting valid data again.

In August, data were lost for 87 hours due to the same problem of an improperly seated filter. This time the problem was detected more quickly and less data were invalidated.

Valid data return from the meteorological instrumentation monitoring period from September 21, 2000 to August 31, 2001 was very high. From a possible 8269 hours available during this time, 8235 hours of valid WS data were collected, for a 99.6% valid data return. For WD, 8265 hours were collected resulting in 99.9% valid data return. The only significant period of data loss was for the WS in December. 30 hours of data were lost due to a data logger collection problem at the same time that the backup recording device malfunctioned.

Attachment 6 has a listing of the monthly Valid Data Return percentages.

Monitoring Results

Comparison to NAAQS

The concentrations of particulate matter measured in the air at this location in Columbus were compared to both the short term (24-hour) and long term (annual) NAAQS.

For comparison to the short term NAAQS of 150 ug/m³, the 24 hourly values recorded for a day are averaged to obtain a daily average. A valid daily average consists of a minimum of 18 hours or 75% of the hourly values from a day. The highest daily average recorded during the study was 75 ug/m³, one-half of the standard. This occurred twice; on 2/8/01 and on 4/20/01. A listing of all the daily averages is in Attachment 7. The values are charted in Attachment 8.

The long term or annual NAAQS is calculated by averaging the four quarterly averages of concentrations collected. To attain the standard, the average must be below 50 ug/m³. Since the sampling period for this study was not a calendar year, the averages were calculated in two ways. Quarterly averages were calculated and for the five different quarters the site was operational, and the average of the quarters was calculated to obtain an average for the sample period. The data are as follows:

	Quarterly Averages
Quarter	ug/m ³
3 qtr 2000	29.0
4 qtr 2000	23.1
1 qtr 2001	19.5
2 qtr 2001	30.1
3 qtr 2001	28.0
Sampling Period Average	25.9

Calculating an average from all the values for the entire period produces an average of 25.2 ug/m³. Regardless of which method is used to calculate the average for the sampling period, the value is approximately one-half of the long term standard.

Comparison to Other Cities

The PM10 concentrations obtained from the Columbus monitoring location were compared to the values collected at representative samplers in other cities throughout Indiana for this time

period. Most PM10 monitors are located in populated or downtown business areas. Two of the sites are located in industrial settings; one site in Gary and one site in Indianapolis. The annual averages obtained for 2000 and 2001 range from 18ug/m³ to 33 ug/m³. All are well below the annual NAAQS. The average of 26 ug/m³ reported from Columbus is less than the industrialized Gary site and the business district sites in Jeffersonville and Evansville and the same as the industrialized area site in Indianapolis. The remainder of the sites range between 18 ug/m³ and 23 ug/m³. The comparison of the annual averages is in Attachment 9.

A comparison of the maximum 24-hour values obtained in 2000 and 2001 from these same sites indicates that the Gary industrialized site exceeded the 24-hour NAAQS of 150 ug/m³ with a reported value of 207 ug/m³. The maximum of 75 ug/m³ reported at the Columbus site was less than the maximums reported at the South Bend and Evansville sites also. The remainder of the sites reported 24-hour maximum concentrations ranged between 47 ug/m³ to 66 ug/m³. Attachment 10 shows the comparison between the cities for the 24-hour maximums.

Comparison to Wind Direction

One advantage of collecting PM10 data continuously as opposed to collecting a filter-based 24 hour integrated sample is the ability to track the particulate concentrations as they rise and fall during the day as a result of the wind direction at the site and the differing activities around the site. A table of WD compared to the different concentrations of PM10 is shown in Attachment 11 and the pollution rose of this data is in Attachment 12. The predominant wind directions for the sampling period were between south and northwest accounting for 56.3% of the time with the southwest direction accounting for largest portion at 9.76%.

The highest hourly concentration of PM10 monitored at the Columbus site during the sampling period was 204 ug/m³. A listing of the highest hourly PM10 concentrations is in Attachment 13.

The number of hours for which both PM10 and WD were collected was 7768. As indicated by the pollution rose, the majority of the higher PM10 concentrations occurred when the winds were from a southerly direction. PM10 hourly averages of 50 ug/m³ or greater were reported during 789 hours or 10.04% of the monitoring period. Of these hours, 660 (83.7%) were recorded when the WD was between 147° (SSE) and 236° (SW). All concentrations of PM10 greater than or equal to 100 ug/m³ were recorded when the WD was between 147° (SSE) and 213° (SSW). There appeared to be no seasonal distribution as the high values with the southerly winds occurred throughout the entire study.

Attachment 14 lists the daily average concentrations that are 50 ug/m³ or greater. The number of hours that the WD was from each direction is also listed. For the two highest days, February 8, 2001, and April 20, 2001, the WD was almost exclusively between 147° (SSE) and 213° (SSW). A review of these days indicate that almost all of these days had the wind blowing from these directions for varying amounts of hours.

The average concentration of PM10 was calculated for all of the hours when the WD was between 147° (SSE) and 213° (SSW), the arc of the direction of the Golden Casting. This value was 37.6 ug/m³. The average concentration calculated for all the hours which had only a south

wind direction (169° - 191°) was 45.7 ug/m³. Both values are below the long term or annual NAAQS.

Conclusions

Neither the short term (24-hour) health standard nor the long term (annual) health standard was exceeded during the sampling period. These are the levels that have been established by USEPA as protective of the public health over these time periods. Both daily and annual average and maximum values were well within the federal standards.

With the exception of a site in Gary which is located in a highly industrialized area, the annual average and the maximum 24-hour concentrations reported from the Columbus site are among the higher values obtained from different sites across Indiana. The values are comparable to those monitored at other industrial locations. The highest PM₁₀ concentrations were recorded when the wind came from the directions between 147° (SSE) and 213° (SSW). Since the Golden Casting facility is the largest source of PM₁₀ in the area and is located approximately 600 feet from the monitoring location between 155° and 220°, the high concentrations of PM₁₀ recorded at the monitoring site are probably due to emissions from this facility.

On the days when the wind was from the direction of Golden Casting for the entire day, the daily average concentration was one-half of the short term NAAQS or less. However, the data clearly show that PM₁₀ levels were higher when the wind blew from the direction of the foundry. These higher levels would likely be discernable to downwind neighbors.

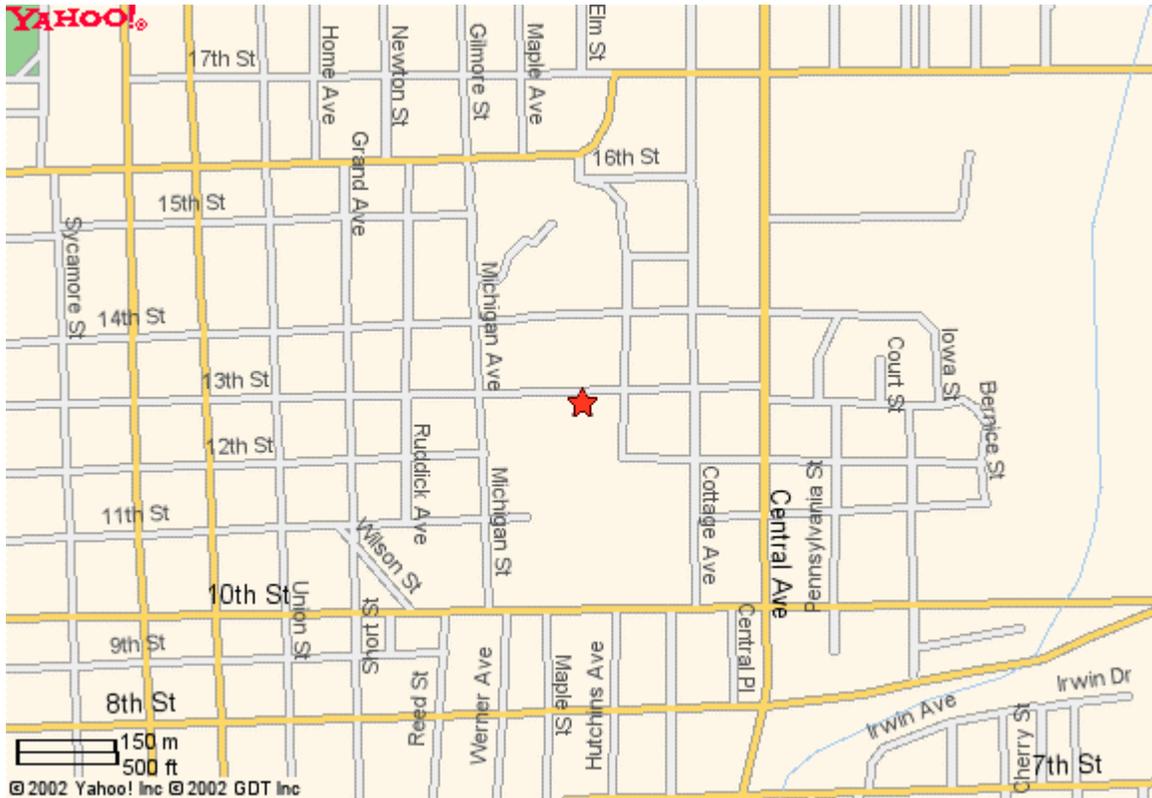
Attachment 1

**Columbus - Arvin Special Study
PM10 Emissions Bartholmew County**

CNTY CODE	PLANT_ID	NAME	STREET	CITY	POLLUTANT	EST EMISSIONS (tons/yr)	UTM NORTHING	UTM EASTING
005	00048	RIGHTWAY FASTENERS INC	7945 S INTERNATIONAL DR	COLUMBUS	PM10	0.031275	4452.007	635.508
005	00053	CUMMINS ENGINE CO. INC.	1460 NATIONAL RD.	COLUMBUS	PM10	0.548	4341.000	596.400
005	00069	CUMMINS, INC. - METC FACILITY	1532 E. 14TH STREET	COLUMBUS	PM10	0.66725	4348.405	587.453
005	00015	CUMMINS ENGINE CO INC	1000 5TH ST	COLUMBUS	PM10	1.22085	4339.400	594.200
005	00066	NTN DRIVESHAFT, INC.	8251 INTERNATIONAL DR.	COLUMBUS	PM10	1.663959	4300.000	680.000
005	00068	VENTRA CORPORATION	1804 22ND STREET	COLUMBUS	PM10	0.09713	4341.700	594.600
005	00002	CUMMINS ENGINE CO #5	1900 MCKINLEY AVE	COLUMBUS	PM10	5.637	4340.700	594.200
005	00086	BARTHOLOMEW CO. LANDFILL	720 SOUTH MAPLETON	COLUMBUS	PM10	5.79	4331.300	593.400
005	00040	TOYOTA IEM, INC.	5555 INWOOD DR.	COLUMBUS	PM10	2.041934	4379.000	641.400
005	00047	CUMMINS MIDRANGE ENGINE PLANT - COLUMBUS	I-65 AT C.R. 450 S. M/C 71327	COLUMBUS	PM10	0.552572	4299.986	680.000
005	00080	ARVIN EXHAUST, TECH. CENTER	950 W. ROAD 450 SOUTH	COLUMBUS	PM10	0.408354	4317.200	601.000
005	00008	ARVIN EXHAUST 17TH STREET PLANT	2020 15TH STREET	COLUMBUS	PM10	0.612375	4341.000	594.200
005	00042	ENKEI AMERICA, INC.	2900 WEST INWOOD DRIVE	COLUMBUS	PM10	20.30286	4332.400	590.400
005	00006	GOLDEN CASTING CORPORATION	1616 TENTH STREET	COLUMBUS	PM10	85.40543	4300.000	680.000
005	00067	DSE, INC. DBA SCREEN TECH DESIGNS, INC.	LOT 118,MIDDLE ROAD,CLMBS ARPT	COLUMBUS	PM10	0.639912	4345.300	595.300
005	05164	MILESTONE CONTRACTORS, L.P.	3415 SOUTH CR 650 EAST	COLUMBUS	PM10	0.320178	4336.039	604.873

Attachment 2

**Columbus – Arvin Special Study
Monitoring Site in Columbus**



★ Columbus – Arvin Monitoring Site

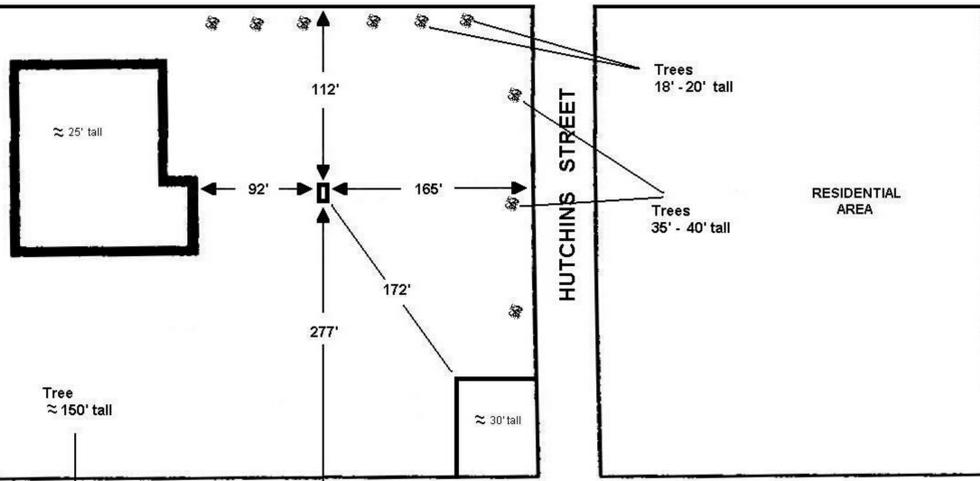
Attachment 3

**Columbus- Arvin Special Study
Monitoring Site Location**

WOOD FACTORY (CUMMINS)

14TH STREET

14TH STREET



HUTCHINS STREET

COTTAGE AVENUE

CENTRAL STREET



13TH STREET

NAA + NAA DUP
ARVIN N.A.A.
BUILDING No. 835
GENERAL OFFICE

HDQTR
ARVIN INDUSTRIES INC
CORPORATE HEADQUARTERS

BKGRD
PRIVATE
COMMERCIAL
PROPERTY

GOLDEN
CASTING

RESIDENTIAL
AREA

CENTRAL STREET

COLUMBUS CAAP (FORMER)

Attachment 4

**Columbus - Arvin Special Study
PM10 Calibration and Audit Results**

Date	Audit/Cal	High Flow	Low Flow
		Limit = +/- 10%	Limit = +/- 0.2 LPM
8/22/00	Cal	-2.2%	0.08
9/13/00	Audit	-2.9%	-0.07
9/29/00	Audit	-8.0%	0.10
10/23/00	Audit	-1.6%	-0.10
11/14/00	Pre Cal Audit	-5.5%	0.16
	Cal	1.2%	0.16
11/20/00	Audit	-3.1%	-0.14
12/18/00	Audit	-4.1%	-0.20
1/4/01	Audit	-4.3%	-0.16
1/29/01	Audit	0.9%	-0.05
2/26/01	Audit	-0.9%	-0.05
3/5/01	Pre Cal Audit	2.2%	0.14
	Cal	2.1%	0.12
3/30/01	Audit	2.5%	0.03
4/23/01	Audit	8.2%	0.09
5/21/01	Audit	1.8%	0.01
6/20/01	Audit	2.3%	0.20
7/17/01	Audit	2.2%	0.04
8/8/01	Audit	5.6%	0.10
9/6/01	Audit	5.6%	-0.07

Attachment 5

**Columbus - Arvin Special Study
Meteorological Monitors Calibrations and Audits**

		WS			WD			
		Comparison of Anemometer to WS Standard			Comparison of Vane Response to Reference Point		Linearity of Vane Response	
Date	Cal / Audit	Range (mph)	Result (mph)	Limit (mph)	Result (degrees)	Limit (degrees)	Result (degrees)	Limit (degrees)
9/21/00	Cal	0-35.0 (4 speeds)	-0.1 to 0.2	+/- .5	1.1	+/- 5	5.0 deg	10
1/1/01	Audit	0-54.8 (4 speeds)	0.1 to 0.2	+/- .5	0.4	+/- 5	5.6	10
3/9/01	Cal	0-43.8 (4 speeds)	0.1 to 0.4	+/- .5	4.4	+/- 5	8.7	10
9/6/01	Audit	0-54.8 (4 speeds)	0.1 to 0.3	+/- .5	-0.6	+/- 5	4.9	10

Attachment 6

**Columbus - Arvin Special Study
Valid Data Return (VDR)**

2000	PM10				WS/WD	WS		WD	
	Total Hours Possible	Valid Hours	VDR	Valid Days*	Total Hours Possible	Valid Hours	VDR	Valid Hours	VDR
August	230	230	100.0%	9					
September	720	712	98.9%	30	229	229	100.0%	229	100.0%
October	744	734	98.7%	31	744	744	100.0%	744	100.0%
November	720	711	98.8%	30	720	720	100.0%	720	100.0%
December	744	741	99.6%	31	744	714	96.0%	744	100.0%
2001									
January	744	738	99.2%	31	744	743	99.9%	743	99.9%
February	672	669	99.6%	28	672	672	100.0%	672	100.0%
March	744	739	99.3%	31	744	742	99.7%	742	99.7%
April	720	717	99.6%	30	720	720	100.0%	720	100.0%
May	744	741	99.6%	31	744	743	99.9%	743	99.9%
June	720	362	50.3%	14	720	720	100.0%	720	100.0%
July	744	737	99.1%	31	744	744	100.0%	744	100.0%
August	744	655	88.0%	26	744	744	100.0%	744	100.0%
Total	8990	8486	94.4%	353	8269	8235	99.6%	8265	100.0%

PM10 data collection
began on August 22, 2000

WS/WD data collection
began on September
21,2000

* Days with >75% VDR (18 hr+)

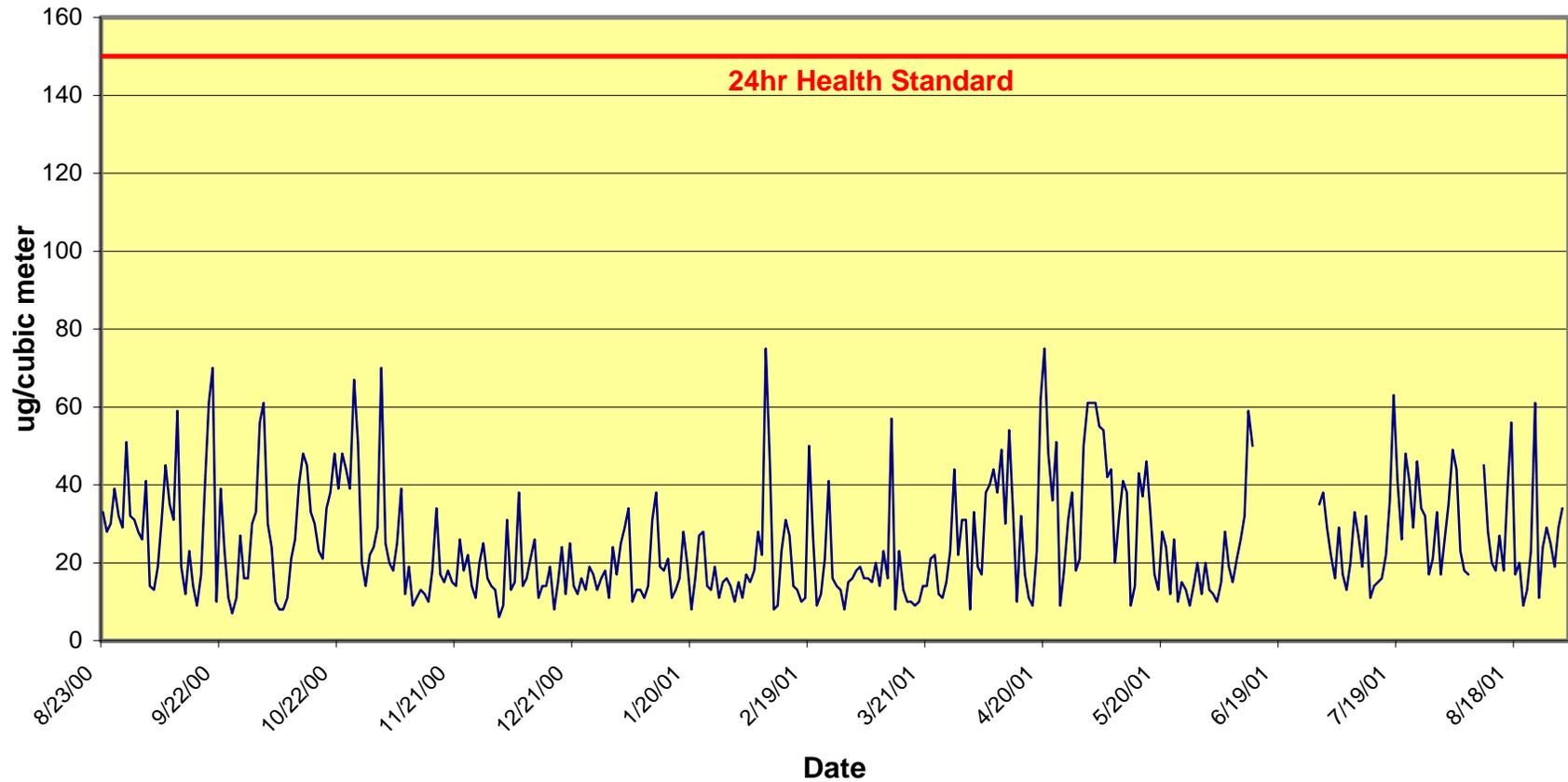
Attachment 7

Columbus - Arvin Special Study PM10 24-Hour Concentrations

Units = ug/m3

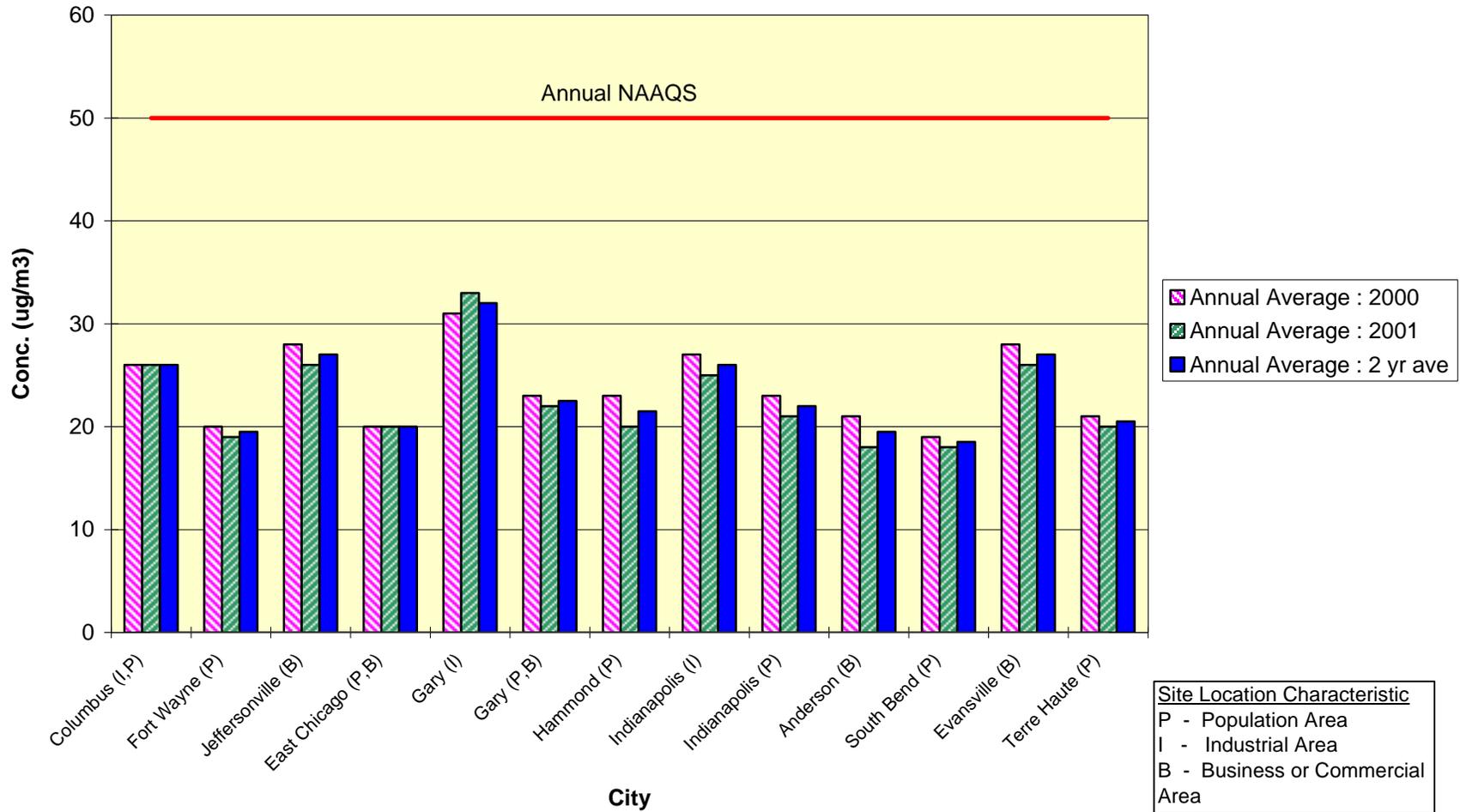
DAY	2000					2001							
	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
1		28	33	29	13	17	15	15	8	61	13	22	49
2		26	56	70	6	25	11	16	33	61	12	16	44
3		41	61	25	9	29	17	18	19	61	10	29	23
4		14	30	20	31	34	15	19	17	55	15	17	18
5		13	24	18	13	10	18	16	38	54	28	13	17
6		19	10	25	15	13	28	16	40	42	19	20	
7		31	8	39	38	13	22	15	44	44	15	33	
8		45	8	12	14	11	75	20	38	20	21	27	
9		35	11	19	16	14	45	14	49	32	26	19	45
10		31	21	9	21	31	8	23	30	41	32	32	28
11		59	26	11	26	38	9	16	54	38	59	11	20
12		19	40	13	11	19	23	57	33	9	50	14	18
13		12	48	12	14	18	31	8	10	14		15	27
14		23	45	10	14	21	27	23	32	43		16	18
15		14	33	18	19	11	14	13	17	37		22	39
16		9	30	34	8	13	13	10	11	46		36	56
17		17	23	17	15	16	10	10	9	33		63	17
18		40	21	15	24	28	11	9	23	17		41	20
19		61	34	18	12	19	50	10	62	13		26	9
20		70	38	15	25	8	27	14	75	28		48	13
21		10	48	14	14	16	9	14	48	24		41	23
22		39	39	26	12	27	12	21	36	12		29	61
23	33	23	48	18	16	28	21	22	51	26		46	11
24	28	11	44	22	13	14	41	12	9	10		34	24
25	30	7	39	14	19	13	16	11	18	15		32	29
26	39	11	67	11	17	19	14	15	31	13		17	25
27	32	27	51	20	13	11	13	23	38	9		21	19
28	29	16	20	25	16	15	8	44	18	14	35	33	29
29	51	16	14	16	18	16		22	21	20	38	17	34
30	32	30	22	14	11	14		31	50	12	29	26	
31	31		24		24	10		31		20		35	

Columbus-Arvin Special Study PM10 24-hour Average Concentrations



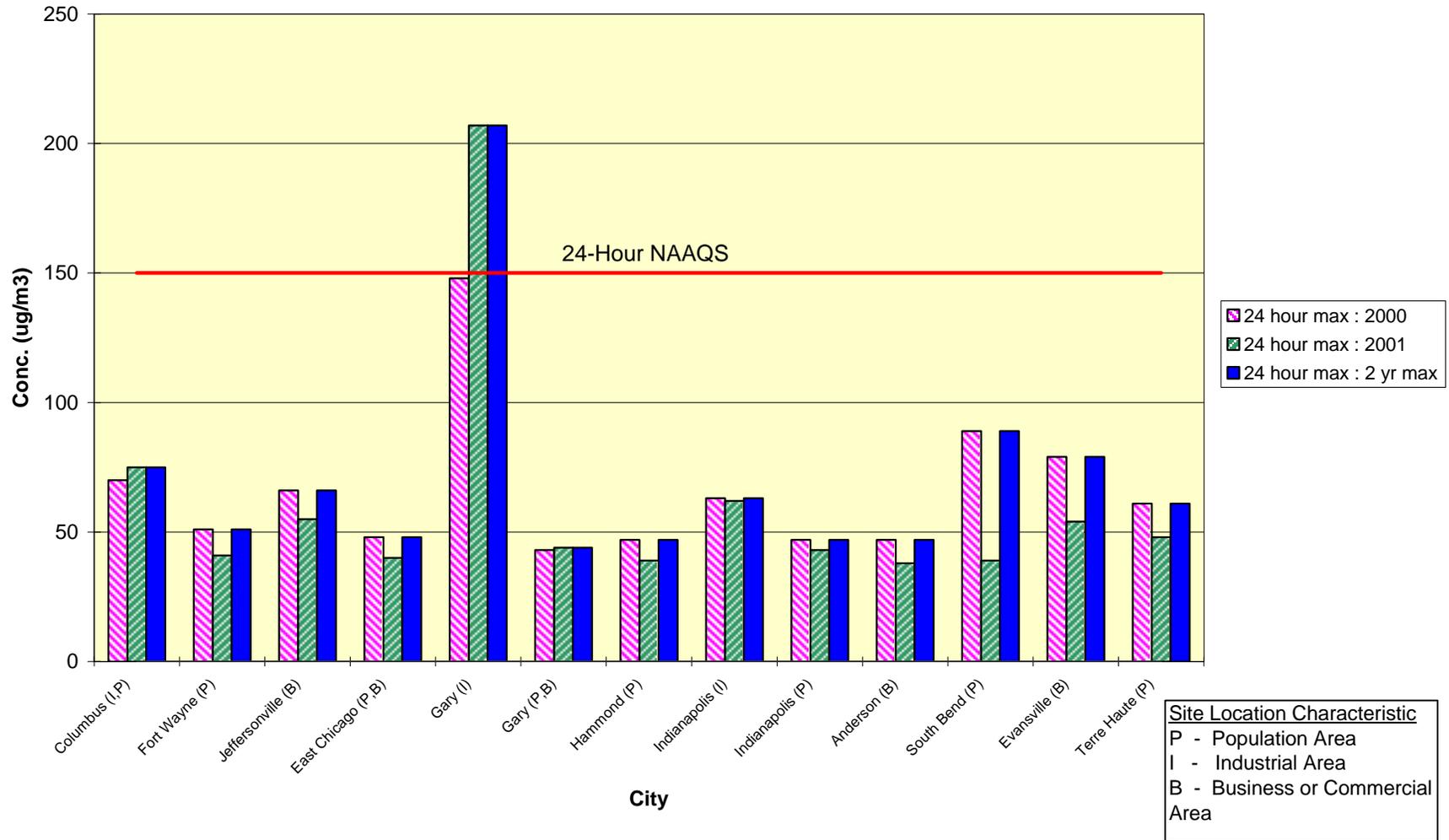
Attachment 9

Columbus - Arvin Special Study Comparison of Annual Values : Columbus Vs Other Cities



Attachment 10

**Columbus - Arvin Special Study
Comparison of 24-Hour Maxs : Columbus Vs Other Cities**



Columbus - Arvin Special Study Frequency Distribution (Concentrations Vs Wind Direction)

Percentage of total period for each concentration category vs wind direction

Concentration Category (ug/m3)	Wind Direction (Degrees)																	Freq per Conc Category
	Calm	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
		349-11	12-33	34-56	57-78	79-101	102-123	124-146	147-168	169-191	192-213	214-236	237-258	259-281	282-303	304-326	327-348	
0-9	0.28	1	1.01	1.01	0.48	0.34	0.25	0.18	0.11	0.16	0.3	0.85	1.22	1.92	1.95	2.29	1.19	14.54
10-19	0.8	2.98	2.65	1.57	1.17	1.71	1.58	1.01	0.66	1.28	1.28	3.03	3.15	4.38	3.48	3.54	3.56	37.83
20-29	1.35	1.43	1.21	0.59	0.7	1.06	1.12	1.35	1.08	1.54	1.56	2.13	0.84	0.97	1.16	1.1	1.18	20.37
30-39	0.46	0.36	0.24	0.15	0.14	0.39	0.74	0.62	1.03	1.69	1.41	1.72	0.58	0.55	0.37	0.29	0.3	11.04
40-49	0.37	0.04	0.05	0.07	0.05	0.19	0.25	0.3	0.57	0.97	1.43	0.97	0.35	0.2	0.12	0.09	0.05	6.07
50-99	0.41	0.01	0.05	0.03	0.05	0.17	0.38	0.41	1.1	2.75	2.45	1.06	0.22	0.16	0.1	0.05	0.02	9.42
100-149	0	0	0	0	0	0	0	0	0.05	0.47	0.16	0	0	0	0	0	0	0.68
>=150	0	0	0	0	0	0	0	0	0.04	0.01	0	0	0	0	0	0	0	0.05
Percentage of Time per Direction	3.67	5.82	5.21	3.42	2.59	3.86	4.32	3.87	4.64	8.87	8.59	9.76	6.36	8.18	7.18	7.36	6.3	100

Number of hours for each concentration category vs wind direction

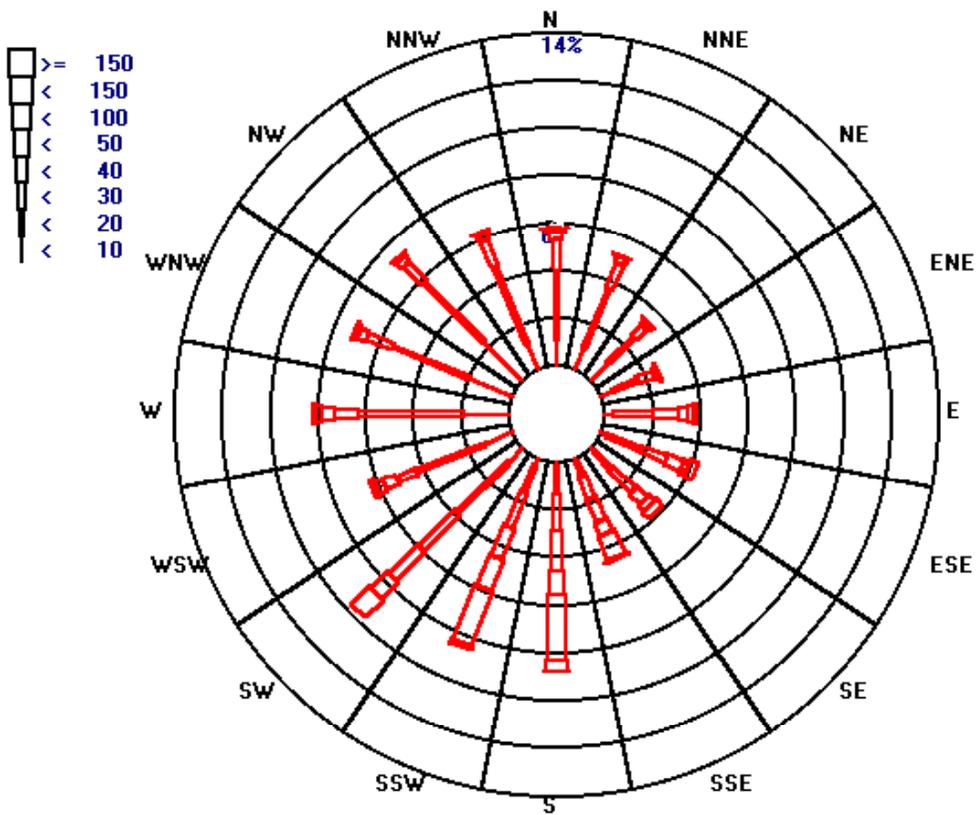
Concentration Category (ug/m3)	Wind Direction (Degrees)																	# of Hours per Conc Category
	Calm	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
		349-11	12-33	34-56	57-78	79-101	102-123	124-146	147-168	169-191	192-213	214-236	237-258	259-281	282-303	304-326	327-348	
0-9	22	78	78	78	37	26	19	14	9	12	23	66	95	149	151	178	92	1129
10-19	62	231	206	122	91	133	123	78	51	99	99	235	245	340	270	275	277	2939
20-29	105	111	94	46	54	82	87	105	84	120	121	165	65	75	90	85	92	1582
30-39	36	28	19	12	11	30	57	48	80	131	110	134	45	43	29	23	23	858
40-49	29	3	4	5	4	15	19	23	44	75	111	75	27	16	9	7	4	472
50-99	32	1	4	2	4	13	30	32	85	214	190	82	17	12	8	4	2	732
100-149	0	0	0	0	0	0	0	0	4	37	12	0	0	0	0	0	0	53
>=150	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	4
# of Hours per Direction	285	452	405	266	201	300	336	301	360	689	667	758	494	635	558	572	489	7768

Attachment 12

Columbus – Arvin Special Study Frequency Distribution Rose PM10 Concentration Categories Vs Wind Direction

Conc. Categories (ug/m3)

Time Period : 8/22/00 to 8/31/01



Calm Percentage : 5.82%

Total Hours Compared : 7786

Each Division = 2% of Time

Attachment 13

**Columbus - Arvin Special Study
High PM10 Hourly Conc. Vs WD**

Rank	PM10 Hourly Average (ug/m3)	WD Hourly Average (degree)	Date	Hour
1	204	176	3/12/01	12
2	162	167	3/12/01	11
3	156	na	9/20/00	7
4	154	168	8/16/01	6
5	154	167	8/16/01	7
6	150	na	9/20/00	6
7	144	202	10/2/00	20
8	144	173	3/12/01	14
9	142	190	2/8/01	10
10	142	173	7/3/01	6
11	142	177	8/22/01	9
12	141	187	8/16/01	8
13	138	201	10/2/00	19
14	133	204	2/8/01	11
15	132	208	12/7/00	10
16	132	177	2/8/01	7
17	132	181	4/20/01	8
18	131	na	9/19/00	18
19	131	177	11/2/00	11
20	131	172	7/17/01	6
21	130	172	8/22/01	8
22	129	169	5/1/01	20
23	128	173	8/16/01	5
24	126	na	9/20/00	8
25	124	na	9/20/00	13
26	124	174	8/22/01	6
27	117	182	4/23/01	6
28	116	196	10/2/00	18
29	115	162	11/2/00	8
30	115	190	2/19/01	5
31	114	165	11/2/00	10
32	113	na	9/20/00	9
33	113	181	2/8/01	8
34	113	180	8/9/01	6
35	112	169	11/2/00	13
36	112	201	12/7/00	12
37	112	173	2/24/01	14
38	112	178	2/24/01	22
39	112	184	4/19/01	18
40	110	na	9/20/00	5
41	110	197	10/3/00	17
42	110	166	10/26/00	21

Rank	PM10 Hourly Average (ug/m3)	WD Hourly Average (degree)	Date	Hour
43	109	na	8/23/00	0
44	109	159	11/2/00	9
45	108	192	11/2/00	12
46	108	165	11/16/00	10
47	108	186	5/1/01	21
48	107	190	2/9/01	8
49	107	172	4/11/01	16
50	106	188	2/8/01	9
51	106	188	3/12/01	15
52	105	na	9/20/00	14
53	105	189	10/3/00	16
54	105	206	10/3/00	18
55	105	206	12/7/00	13
56	105	170	4/11/01	20
57	105	173	4/11/01	21
58	104	na	8/22/00	23
59	104	174	2/8/01	18
60	104	189	2/24/01	23
61	104	171	4/20/01	7
62	104	191	4/20/01	18
63	101	201	12/7/00	11
64	100	170	2/8/01	6
65	100	181	2/20/01	6
66	100	181	4/19/01	8
67	100	192	5/2/01	14
68	99	190	2/19/01	8
69	99	171	8/22/01	5
70	98	179	4/19/01	21
71	98	184	5/2/01	15
72	97	na	9/20/00	16
73	97	204	10/26/00	17
74	97	170	3/12/01	13
75	97	203	7/17/01	7
76	96	172	4/20/01	20
77	95	170	4/20/01	6
78	95	189	8/22/01	10
79	95	203	8/30/01	6
80	94	na	8/22/00	22
81	94	na	9/19/00	21
82	94	164	10/26/00	20
83	94	135	11/2/00	15
84	94	182	4/19/01	19
85	94	177	4/19/01	20
86	94	199	4/23/01	13
87	94	178	5/16/01	20
88	93	179	10/26/00	22
89	93	180	5/3/01	8
90	93	175	7/18/01	1

Rank	PM10 Hourly Average (ug/m3)	WD Hourly Average (degree)	Date	Hour
91	92	174	9/22/00	16
92	92	173	5/1/01	5
93	92	197	8/9/01	7
94	92	199	8/16/01	9
95	91	na	9/1/00	18
96	91	169	4/11/01	18
97	91	191	4/23/01	7
98	91	189	5/1/01	7
99	91	189	7/17/01	4
100	91	197	8/8/01	14

Attachment 14

Columbus - Arvin Special Study
Maximum 24-Hour Concentrations Vs Number of Hours per Wind Direction

Rank	24-hr Conc. (ug/m3)	Date	Wind Direction (Degrees)																
			Calm	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	WNW
1	75	2/8/01	2	349-11	12-33	34-56	57-78	79-101	102-123	124-146	147-168	169-191	192-213	214-236	237-258	259-281	282-303	304-326	327-348
2	75	4/20/01								1	4	12	5						
3	70	9/20/00	Not Available																
4	70	11/2/00	8						1	2	4	3	1	2			1	2	
5	67	10/26/00	6						1		4	5	3	2	1		1		1
6	63	7/17/01							1	1		3	9	10					
7	62	4/19/01	1						1	3	8	9	2						
8	61	9/19/00	Not Available																
9	61	10/3/00								4	8	6	4	2					
10	61	5/1/01									8	10	6						
11	61	5/2/01								1	8	3	7	4					
12	61	5/3/01	7						1	2		2	3	7	1	1			
13	61	8/22/01						1		1	4	12	5	1					
14	59	9/11/00	Not Available																
15	59	6/11/01								2	1	11	9	1					
16	57	3/12/01						3	5	1	4	8	3						
17	56	10/2/00									2	8	5	9					
18	56	8/16/01								1	6	2	4	3	1	4	3		
19	55	5/4/01	3			1			1		1	6	10	1					
20	54	4/11/01			1			1	3	3	1	12	3						
21	54	5/5/01		1	2	2	4	6	2	2						2		2	1
22	51	8/29/00	Not Available																
23	51	10/27/00	1									2	4	4	2	7	1	2	1
24	51	4/23/01										5	14	1	2		2		
25	50	2/19/01										7	7	5					
26	50	4/30/01	4					1			2	2	6	5		1	2		1
27	50	6/12/01						2	1			3	2	9	6	1			